ME 3023 Challenge 4 – Oscilloscope

Learning Objectives

Students will demonstrate use of a digital oscilloscope, a multimeter, a function generator to generate and collect data for AC time signals. Completing this lab will help ensure the student can:

1. operate basic functions of a laboratory oscilloscope to perform voltage and frequency measurements on a time varying waveform from a function generator,
2. apply the concepts and definitions of RMS Voltage, Peak-to-Peak Voltage, and Voltage Amplitude and demonstrate how they are related for a sinusoidal waveform,
3. operate a multimeter to measure RMS voltage and frequency output from a function generator, and
4. determine appropriate statements of uncertainty for oscilloscope and multimeter measurements.

Background

Consult the user manuals for the function generator and the oscilloscope. You may also find it helpful to view video tutorials on-line for use of Tektronix TBS1000C oscilloscopes. Recall the relationships between voltage amplitude units of $V_{pk\text{-}pk}$ and V_{rms} and V_{pk} for sinusoidally varying waveforms.

Setup Notes:

During this set of activities, you will send the function generator output to two devices, or to two channels on one device. Hint: Using a t-joint BNC connector will make this easy.

Activity 1 - Using the Multimeter to measure function generator output

Connect the Function Generator output to the multimeter to measure AC Volts in units of peak, and to measure the frequency of the function generator output. Use the function generator to produce a **Frequency 1** sinusoidal waveform with **Amplitude 1**.

Record the values for the measured amplitude and frequency of the signal

Amplitude, V_{AC}: _____ Frequency, F: _____

Don't forget the units. Determine an appropriate statement of uncertainty for each measured value above, showing all work.

Activity 2 – Getting to know the oscilloscope – using built in tutorials

Complete two tutorials built into the TBS1000C oscilloscope (Press Help, then select Course, select ScopeTutorials, use the Multipurpose knob rotating ccw to scroll down the list). The tutorial will guide you to set a function generator to different frequency and amplitude, so you will need to adjust your settings from Activity 1.

- Scope Tutorial 1. RMSMeasurement
- Scope Tutorial 3. CursorPkPkMeasurement

Take screen shots of the display after completing each tutorial to include in your writeup, along with observations of what you learned from the tutorial.

Activity 3 Single Channel Sine wave capture

Reset the function generator to once again produce a **Frequency 1** sinusoidal waveform with **Amplitude 1**.
Adjust the time scale on the oscilloscope using the **Time/Div** control to display approximately N_cycles of the waveform. Adjust the **Volts/Div** knob so the waveform fills N_vertical divisions, see Figure 1 for an example.

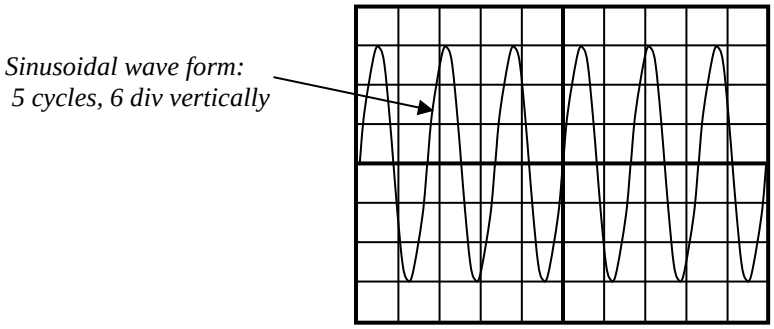

Figure 1: Example Sinusoidal Waveform, with N_cycles = 5, and N_vertical = 6

3a) Visually measure (by counting number of divisions on the display) the amplitude and period of the waveform. Consider the resolution of the scales of each axis in the display.

Waveform amplitude, V_{pk} = _____ Time duration for N_cycles = _____

Don't forget units with your answers, and include a photo image from the scope in your write-up.
Using the visual measurements above, compute the values listed below. Show all calculations!

RMS Voltage: V_{rms} = _____
Period, T for one cycle: T = _____
Waveform frequency: f = _____

3b) Using the **MEASURE** menu options, set up measurement fields to show on the screen with Channel 1 measurements of Pk-Pk, Cyc RMS, Period, and Freq. Record the values you see displayed for each measurement. Units must be included in your answers. Be sure to include a photo image of the o-scope screen in your write-up.

Pk-Pk: _____ Cyc RMS: _____

Freq: _____ Period: _____

Determine appropriate statements of uncertainty for the oscilloscope measurements. Justify your values with reference to user manual page(s), consideration of accuracy, digital display resolution, etc. Be sure to show all calculations.

Activity 4 – Using a Tektronix Probe, TPP0100, 10x Attenuator

Connect the function generator output (same settings as Activity 3) to both oscilloscope channels, using the BNC cable to channel 1, and connecting the Tektronix Probe to channel 2. See the short video posted in the Equipment Manuals section of iLearn about using the Tektronix Probe, you are learning this to get ready for Challenge 4. Use the MEASURE settings to display the FREQ and Pk-Pk for channel 1 and for channel 2. Explore what happens when you use the channel 2 setup to change from 1X to 10X attenuation. Discuss your observations. Include a picture of your screen display in your writeup.

Observations and Discussion:

During Activity 1 and Activity 3, you used two distinct devices to measure the output from a function generator. Compare the results from both devices and discuss what you observe from the comparison, including what you can declare regarding uncertainty for each device.